THE DESCRIPTION OF 1st- 3rd GRADER STUDENTS' THINKING LOGIC IN SOLVING PROBLEMS OF ONE VARIABLE LINEAR EQUATION

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Abstract

One variable linear equation is a subject taught in Junior High School (SMP) and Senior High School (SMA). The materials require connection to daily life activities so that it can help students to learn. Teachers often directly giving formula or an example while they teach one variable linear equation material at school. Direct teaching using symbols will ostruct understanding. This research gives problem about one variable linear equation for 1st-3rd grader students in Elementary School. Based on the student answers, reseacher studied the student logical thinking in solving the problem. This research used an unstructure interview method to three elementary school students, that were 1 from first grader, 1 from second grader, and 1 from third grader. The result is students were able to solve one variable linear equation problems using concrete things which students often found in their daily life. The 1st and 2nd graders used recurring addition concept, whereas the 3rd grader used division and multiplication concepts, which had been taught earlier in third grade of Elementary School.

Keyword: logical thinking, 1st-3rd grader students, one variable linear equation

Introduction

Background

One variable linear equation is one of the Mathematics materials taught in the middle school. This material is basic to linear equation of two variables and also a part of the algebra. Students can study this topic after they learn about arithmetic operations for algebra (Nuharini & Wahyuni, 2008). This topic enables teachers to manipulate the algebra with concrete examples in the instructional.

In the practice of instructional about one variable linear equation in school, teachers have been using formulas and illustration in a form of mathematical symbol for the students. The illustration usually uses the symbol of x, y, z, a, b, c, etc. instructional without using the symbol will make difficulties for students to understand and relate the material with the daily life problems. The topic of one variable linear equation needs a concept comprehension, such as, relating the study material with daily life so it makes students easier to learn.

Through the Department of Education and Culture, the government has taken considerations to arrange the order of mathematics learning topics that it helps learners to study well in every level. This research based on the curiosity whether primary school students of 1–3 graders can solve the problems of one variable linear equation by giving problems existing in daily life. The problems were given to 1–3 graders students, and never before used by the teachers.

8-years-old children have already known how to 'borrow' and 'bring', so they can do addition, and even multiplication and division (Cooper et al, 2009). This underlies the start point of the research, that is, to find out the thinking logic of 1-3 grader students in solving the problems of one variable linear equation. Thinking logic is created by students', influenced by the situation of self and the environment. Thinking logic is the students' cognitive construction through a unique thinking algorithm. Van de Walle (2008) pointed out that children do not absorb the teacher's ideas; rather, they are the creator of ones. As children create crate their knowledge, they are possible to understand and solve one linear equation through daily life problems. This description is significant since teachers need to know students; thinking logic when facing a new problem that has never been taught before.

Theoretical Framework

Mathematics Instructional in Schools

Teachers still often hear an opinion that mathematic is difficult. Variations in teaching strategies are necessary in order to find appropriate ways to teach mathematics that the students can understand. Various teaching which enable learners to feel secure in the learning environment, to enrich learning and to assist the learning process should be utilized (Ozden & Gultekin, 2008). Various teaching strategy motivates students to learn. Van de Walle (2008) confirmed the importance of teacher having collections of strategies for the class, since one strategy may be applicable for one student but notfor the others.

One Variable Linear Equation (OVLE)

This topic is given to students of grade VII or in the middle school level. It is an introduction to one variable linear equation, also to the quadratic equation. The prerequisite material that the students must have mastered is the algebra arithmetic operation. Usually, this material starts by understanding the definition of open-ended question, variable, and constants (Wagiyo, Surati, & Supradiarini, 2008; Wintarti et al, 2008; Nuharini &

Wahyuni, 2008). This knowledge, whether was realized or not, had been learned since in primary school, yet it was not specifically aimed to that material.

A variable, in this case, is a symbol in an open-ended sentence that can be changed with any defined set member (Nuharini & Wahyuni, 2008). For instance, a student buys two candies for Rp.1.000,00, then; the price of one candy can be defined. Based on field observation, the result showed that students could count naturally, because they have experienced buying candies as what was told.

The Process of 1-3 Grader Students Thinking Logic

Based on Piaget's stages of development, students of 1-3 graders are in concrete operation stage. Their thinking processes are organized in a bigger mental process system which makes it easier to them to think logically rather than before (Ormrod, 2009). This thing lets the students think naturally, in the environment outside the school.

Student can also develop their understanding through cognitive models that they receive. Jaones, Langrall, & Thornton (2002) stated that cognitive models incorporating key elements of a content domain and the processes by which students grow in their understanding of that content have been constructed for many of the extant mathematics domain (e.g., whole numbers, rational numbers, geometry) as well as some of the underrepresented domains (e.g., probability and statistics).

In this stage, students are broadening their ability to conserve, to group adequately, to make orders (from smallest to biggest and vice versa), and handle the concept of numbers (Hergenhahn & Oslon, 2008). Thus, in this stage, children are able to solve the problem of one variable linear equation through grouping, making orders, or other way. However, the variable used still must be made concrete for the children to understand the problem. As the children are still in the stage of developing, there can be mistakes in solving the proposed problems. By this, the thinking process requires logic.

Logic is the noun for an adjective. It is derived from ancient Greek word *logos*, which means the result of consideration from the mind that is expresses in words of language. Logic is one of the philosophy fields. As a science, logic is phrased as *episteme logis* (Latin: *logicascientia*) or the science of logic, which studies about skills to think straight, precisely, and orderly. Science refers to a rational ability to perceive and skills to reasoning for actualizing knowledge to action (Wikipedia, 2014). According to Uno & Kuadrat (2009), logic is a scientific discipline founded by Aristotle, developed with arguments, validity, evidences, definition, and consistency. When the formal logic was unknown, people used logic as consideration in determining and deciding something. It is in line with Sumaryono (1999) had stated that as long as logic gives evidence aiming for truth, in the form (validity) and also in material (truth), thus, an argument or a new reasoning can be said as logic if the argument or reason is valid and in the same time true–not only stands for one. Syukur (2004) defined thinking as the use of human reasoning to consider or deciding something. Therefore, it can be concluded that thinking logic is the application of reasoning through one's cognitive consideration to determine or decide a thing appropriately in problem solving.

Research Method

This is a descriptive qualitative research as the result describes about the thinking logic of 1–3 graders primary school students in solving the problems of pone variable linear equation, and the data analysis is given in words. The subjects were 3 primary school students, consists of each one person in grade 1, 2, and 3. They were chosen based on the ability to communicate their own ideas well.

As this is a qualitative research, the key instruments were the researchers themselves (Creswell, 2014). The data was collected from observation results, unstructured interview, and documentation. The interview was done by giving the students mathematic problems of one variable linear equation related to the daily life. Based on the students' answers, the thinking process was investigated that it made the researchers discovered the thinking logic of the students in solving the given problems.

The steps in the research were: a) proposing a problem to students of one variable linear equation related to the daily life by using concrete objects to make students easier to think and give the answer; b) giving the students time to think; c) asking the students to reveal their thinking process in solving the problem; d) giving another problem with the higher level of difficulty; e) giving the students time to think and answer; f) asking the students to reveal their thinking process solving the problem; and kept investigating students' answers until the purpose of the research was reached, that is, to discover the students' thinking logic in solving the problems of one variable linear equation without using illustration (variables); also g) based on the students' answers, the researchers were analyzing the data result about the thinking logic.

Research Results

The result of this research is to answer the research question about thinking logic of 1^{st}–3^{rd} graders primary school students in solving the problems of one variable linear equation. The data was collected based on the observation results, interview, and documentations. The researchers proposed the problems of one variable linear equation using familiar concrete objects to students, such as bread, chocolate, pencils, pens, rubbers, books, shampoo, matches, wafer, candies, coloring box, snack, marbles, and money. The proposed problems were arranged in 4 levels of difficulties.

Below are the descriptions of the results about the stunts thinking logic.

The Description of the 1st Grader Student Thinking Logic

First Step (Problems with OVLE Type 1)

The first step was to propose the problem of one variable linear equation with an amount of an object. The researcher asked, "If we fill two jars with the same amount of candies, and total of the jar is 4, how many candies are there in one jar?". The students gave an answer that one jar had two candies, because they knew that 2 + 2 = 4 that corresponded with two jars with 4 candies would be 2 candies each inside. Then the researcher proposed a more difficult question. The students could answer that the total of the objects in two jars is a unit number of 1–9. They could also answer the total amount of all objects, which were in number of tens of 10–20. However, the students could not answer for problems with number of tens of more than 20, whichalso happenedthe same when they had to count all objects in two jars in number of 10–20. In solving that problem, the children used recurring addition thinking logic.

In the first step, the researcher also proposed a higher level problem with 3 amounts of jars. The question was, "If we fill three jars with the same amount of candies with the total candies of 12, how many candies are there in each jar?". The student answered that there were 4 candies in one jar. They also answered the total amount of objects of 12, 15, 18, and 24. The students used the recurring addition concept.

Based on the explanation above, it is concluded that the students of grade 1 can solve the problem of one variable linear equation related with the total of the objects using the recurring addition thinking logic. The students used it for two and three numbers addition. In two numbers addition, the students could operate in 1–10 and 20. In three numbers addition, the students could operate until number 24.

Second Step (Problems with OVLE Type 2)

The researcher proposed the problem of OVLE related to a price of something using familiar daily object. The problem was "Syifa bought 2 snacks at the foodstall for Rp.2.000,00. How much is the price of one snack?". The students answered that one snack cost Rp.1.000,00, because the student knew that 1000 + 1000 = 2000. Then another problem with the higher difficulty level was given. The students could operate the equation that if the price of 3 was Rp.3.000,00, then one would cost Rp.1.000,00, and it went until the price of Rp.7.000,00 for 7 objects that would make Rp.1.000,00 for each. However, in the price level of 8x = Rp.8.000,00, the student could not give an answer for one object. In tens of thousands level, the problem given was "Syifa bought 2 chocolates for Rp.20.000,00. How much is one chocolate cost?". The answer from the student was Rp.10.000,00 for each chocolate, because 10.000 + 10.000 = 20.000. Then the problem with the higher level of difficulties was given, and the students could answer that the price of 3 chocolates was Rp.30.000,00 that made the price of Rp. 10.000,00 for each one. It went until the level of 7x = Rp.70.000,00 with the price of Rp.10.000,00. However, when it reached Rp. 80.000,00, the student couldn't answer the price for one. The researcher helped the students to think using real money, but there was still no correct answer. The thinking logic used was the recurring addition.

In the second step, the harder level of one variable linear equation problem was given with "Syifa bought 3 pencils for Rp. 9.000,00. How much is the price of one pencil?". There was a correct answer of one pencil that cost Rp.3.000,00. The student did the operation using 9 fingers, and illustrated that 1 finger stood for Rp.1.000,00. 1 pencil was illustrated by 3 fingers, the it was added as 3 + 3 + 3 = 9 that turned out as correct. The students then concluded that 1 pencil = 3 fingers = Rp.3.000,00. The next more difficult problem was given, that is 3x = Rp.18.000,00 and 3x = Rp. 21.000,00. They were correctly answered that each pencil cost Rp.6.000,00 and Rp.7.000,00. The student thought using the tally written on a paper because the fingers were only 10. The student illustrated that 1 tally was Rp.1.000,00, then drawing as many tally according to the total price (Rp.18.000,00 for 18 tallies and so on). After that, the student tried to illustrate 1 object using the tally until the correct answer was found and made a conclusion. The student could not answer the price of 1x from 3x = Rp.24.000,00. The researcher gave further assistance with an example of real money of Rp.24.000,00, but it remained unanswered.

Based on the above description, it can be taken that the students used the recurring addition thinking logic in solving OVLE problem in daily life. In the recurring addition of thousands and tens of thousands, the logic reached no more than Rp.8.000,00 and Rp.80.000,00. If the students have known about the recurring addition, the question could be answered, if not, they would use tally and help of fingers. The students counted with the help of fingers if the total amount was ≤ Rp.10.000,00, and use the tally if the total amount is > Rp.10.000,00. At first, the student illustrated one finger/tally = Rp.10.000,00, then 1 object x with the tally/finger until they got the expected number. The students could make a desicion that 1 object = x finger/tally = Rp.x.000, where x represented the amount of finger/tally of 1 object.

Third Step (Problems with OVLE Type 3)

In the third step, the researcher gave a problem about the price of an object, where the price was not in integers amount of money, for example: Rp.1.200,00, Rp.4.400, etc. The first problem was "Syifa bought 2 cacaos at the food stall for Rp.1.000,00. How much is the price of 1 cacao?". The student gave an answer of Rp. 500,00 because the students knew that 500 + 500 = 1000. A correct answer was also given for the problem

"Syifa bought 4 anti-mosquito lotion packs for Rp. 10.000,00. How much is one pack?". The student used fingers and illustrated that 1 finger was Rp.1.000,00. As there were 4 packs, 1 pack was represented by 2,5 finger. 2,5 finger = Rp. 2.500,00 so the student knew that 1 pack was Rp.2.500,00. Then a new problem was given, 2x = Rp.1.600,00, 2x = Rp.3.000,00, 2x = Rp.30.000,00, 3x= Rp.24.000,00, 4x= Rp. 1.200,00, 4x = Rp.4.400,00, and also the price of 1x. The student could not answer to the problem's question, where the researcher helped them out by giving the real money as much as the amount known, yet the students still could not give an answer.

Based on the explanation above, it is concluded that the thinking logic of the students in solving the problem of OVLE was the recurring addition with the help of fingers which let them illustrate half of finger as = Rp.500,00. The students could not give answers to the problems that used the integers in thousands (i.e. Rp. 1.200,00, Rp.2.400,00, Rp.4.400,00).

Fourth Step (Problems with OVLE Type 4)

The problems given were even more difficult with the problem stated "Syifa buys 2 Malkist for Rp. 1.000,00. If she wants to buy 3 malkists, how much will she have to pay?. The students gave the correct answer that the price of 3 malkists = Rp.1500,00. First, the students searched for the price of 1 maklist thats Rp.500,00, because they knew that 500 + 500 = 1000. As if Syifa wanted to buy 3 malkists, then the students thought that 3 malkists = 500 + 500 + 500 = 1500, that made the price of 3 malkists = Rp.1.500,00. Another problem was proposed with 2x = Rp.2000,00 and the question was to find out the price for 3x. Firstly, they searched for the price for 1x with the recurring addition concept, that led them to 3x = x + x + x. When another new problem was given, 2x = Rp.10.000,00 and the question was to find out 3x, 2x = Rp.3000,00 fora question of 2x, and also 4x = Rp.8000,00 for a question of 3x. The students could not answer those questions.

The description above drew a conclusion that the students solved the OVLE at the level of problem known by 2x with the question of 3x and some that were similar type. The students started by searching the value of 1x using the recurring addition. Next, they search for the expected answers also with the concept of recurring addition, i.e. 3x = x + x + x. Though, they were only able to answer until the level of 2x = Rp.1000,00 that made 3x= Rp.1.500,00, and also at the evel of thousands 2x= Rp.2000,00 that made 3x = Rp.3000,00, 4x = Rp.4000, and so on, whether the more difficult problems could not be answered.

The Description of the 2nd Grader Student Thinking Logic

First Step (OVLE Problems Type 1)

In the first step, the researcher proposed a problem on the amount of an object. The question was "If two bags of bread has 18 breads with the same amount of bread in each bag, how many breads are there in one bag?". The students answered 9 in each bag, as they knew that 9 + 9 = 18. They could also give an answer for more amounts of bread. The amount of bag was added in "If 3 bags of bread has 9 breads with the same amount in each bag, how many bread does each bag has?", to which the students answered 3 in each bag, as they knew that 3 + 3 + 3 = 9. The students answered the next questions with the same concept of operation, which was the recurring addition, which enabled them to conclude that those problems could be solved with division, which had been taught in grade 2. The students often used fingers and stackable addition, also have figured that the amount of the bread as 'addition number' and the bag as 'repeat number'.

Second Step (OVLE Problems Type 2)

In the second step, the problem was still related to the daily life, that was "If 2 chocolates cost Rp.1.000,00, how much does 1 cost?", to which the students answered Rp.500,00, as they knew that 500 + 500 = 1000, then the recurring addition was done twice. The students could also answer the question when the amount of the object was added until 4, as well as when the price was made higher to thousands. If the students knew about the recurring addition, the question could be answered, if not, the students would go for a trial to count and test the answer. If the answer was wrong, the researcher suggested students redo the counting carefully.

Third Step (OVLE Problems Type 3)

In the third step, the problem presented were in the higher level of difficulty that the value didn't use integers, for example: Rp.1.600,00, Rp.2.100,00, etc. The problem presented was "if 2 rubbers is Rp.1.600,00, then how much does 1 rubber cost?", to which the students solved by omitting the 0 number, reminding the students that 16 was from 8 + 8, that made the price for 1 rubber was Rp. 800,00. The next problem was answered in the same process. The concept of solving was similar with the previous, which used the recurring addition, though it took longer time.

Fourth Step (OVLE Problems Type 4)

The researcher presented the more difficult problems, stated "If the price of 2 cacaos is Rp.1.000,00, then, how much will 3 cacaos be?". The students determined the price of 1 cacao to be Rp.500,00 as they knew that 500 + 500 = 1000. The next step was to count 3 cacaos by adding Rp.500,00 + Rp.500,00 + Rp.500,00 = Rp.1.500,00. The new problem was 2x= Rp.3000,00 with the question of the prive for 4x. Same to the previous for the recurring addition, the students searched for the price of 1x, then processed it to 4x = x + x + x + x. The next problem was also solved with the similar process.

The Description of the 3rd Grader Student Thinking Logic

First Step (OVLE Problems Type 1)

In the first step, a problem was related to an amount of an object, stated "If 2 bags of bread have 6 breads with the same amount in each, how many breads are there in 1 bag?", to which the students answered 3 in each bag. The process they used was that 6 ÷ 2 = 3 (the number of breads divided by the number of bags). The students could answer the question to the similar problem with the higher total amount of bread of 20, 22, until 50. Next, the number of the bags was added with "If 3 bags of bread has 9 breads with the same amount of bread in each bag, how many breads are there in 1 bag?". The student's answer was 3 breads in 1 bag, by counting 9 ÷ 3 = 3. Other next questions were answered in the similar concept, also with the students perceived that the number of the bag was for 'dividers', and the total amount of the bread was the number 'divided'.

Second Step (OVLE Problems Type 2)

The second step was for the problem related to prices of a daily life objects, stated, "If the price of 2 cacaos is Rp.1000,00, how much is one cacao?". The answer given was Rp.500,00 by dividing Rp.1000,00 into two. The students could also answer the problem with more amount of the price to tens of thousands until hundreds of thousands (finding the value of x in the problem of 3x = 3000, 2x = 3000, 3x = 30.000, 2x = 150.000, 4x = 8000). In hundreds of thousands, the students used the division operation taught in school.

Third Step (OVLE Problems Type 3)

The third step was for the higher difficulty level problem, in which the price of the object didn't use the integers, for example: Rp1.600,00; Rp2.100,00; etc. The question was "if 2 rubbers is Rp.1.600,00, then, how much is one rubber?", to which the students answered Rp.800,00. They got the answer by omitting the 0 from the back of the real numbers, for instance, Rp.1.600,00 ÷ 2 then student create 16 ÷ 2 = 8 that made Rp.800,00 for each. The higher level of problem could be answered when the amount of the object was added.When the price was made higher (to find the value of x in 3x = Rp.2.100,00, 4x = Rp.10.000,00, 4x = Rp.4.400), the students took longer time in solving on the third problem.

Fourth Step (OVLE Problems Type 4)

The OVLE problem presented was in the higher level of difficulty. It was "If 2 cacaos cost Rp.1.000,00, how much is for 3 cacaos?", when the students searched for the price for 1 cacao by counting Rp.1.000,00 ÷ 2 = Rp.500,00. After that, they counted for 3 cacaos by multiplying the price of 1 cacao with the requested amount, Rp.500,00 × 3 = Rp.1.500,00. The students were able to answer the next more difficult questions without difficulties, as they have mastered the multiplication and division.

Summary

The students of primary school students 1st grader used the recurring addition thinking logic in solving the problem of One Variable Linear Equation (OVLE), with the following description: (a) in two numbers recurring addition, the students could operate from 1–10 of the amount of the object. In three numbers recurring addition, the students could operate on the amount of numbers up to 24; (b) recurring addition in thousands and tens of thousands, the thinking logic of the students was limited to less than Rp.8000,00 and Rp.80.000,00; (c) the limit of the students' thinking for the recurring addition reached up to 7 and multiples of 7. (d) when the students had not learned about recurring addition, the students used the help of fingers or tally. They illustrated one tally/finger as Rp.1000,00, and then made the object represented by 7 the tally/fingers also. They concluded that 1 tally = Rpx000, where x was the amount of tally/ finger which represented 1 object. The illustration of half of finger = Rp.500,00; (e) the students could not solve the OVLE problem when the numbers were not in integers (for example Rp.1200,00; Rp.2.400,00; Rp.4.400,00), (f) in problem where 2x was known and 3x was questioned, the students, at the first hand, searched the value of 1x with recurring addition. Then, the proposed questions were also answered with recurring addition, for instance, 3x = x + x + x. Therefore, they could only answered up to 2x = Rp.1.000,00, where 3x = Rp.1.500,00, and also in the level of thousands, where 2x = Rp.2000,00 that made 3x = Rp.3000,00, 4x = Rp.4000,00, and so on. In the harder level, the problem could not be solved.

The thinking logic of the students in 2nd grader primary school in solving the OVLE problem was in recurring addition,, and thereby the students concluded that the problem could be solved by divisions, that had been taught in grade 2. The students often used the help of fingers. They could give answers if they had known about recurring addition, if not, they would try to count to prove the answers. When the price were not in integers (such as Rp.1.600,00; Rp.2.100,00, etc), then students would omit the 0 numbers from the price (Rp.1.600,00 became 16), so they understood that 16 is formed from 8 + 8 that create the price for Rp.800,00 for each. The next problems were answered in similar process with longer time. In the last step, where 2x was known and questioned, the students searched the value of 1x with the concept of recurring addition. After that, they continued thinking 4x = x + x + x + x with the recurring addition concept.

The students of 3rd grader primary school solved the OVLE problem related to the total amount and price of an object using the division concept. The students used the tailed division concept for the level of hundred thousand number to separate between real numbers and zero numbers in price without integers. They needed longer time to do the operation. In the last step, the

students used mixed concept with division and multiplication that had been taught in 3rd grader.

The research results bring to a conclusion that students in 1st–3rd graders of primary school are able to solve the one variable linear equation using familiar concrete objects related to their daily life. The thinking logic of each student are different to each other in solving the problem.

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